

# **Public Safety Next Generation E9-1-1 Network**

## **Project Summary**

for the  
**State of California**  
**Department of General Services**  
**Telecommunications Division**  
**California 9-1-1 Emergency Communications Office**



**Agency Order Number 3045107**  
**MSA-IT 01-MA-01, No. 5-01-70-51**

**Issued 04/14/03**

Copyright © 2003 Telcordia.  
All Rights Reserved.

## Contents

1	Introduction .....	1-1
1.1	Project Overview.....	1-1
1.2	Project Management Plan .....	1-1
1.3	Project Deliverables.....	1-2
1.4	Document Structure .....	1-3
2	Network Assessment – Existing California Infrastructure.....	2-1
3	E9-1-1 Needs Analysis.....	3-1
4	Technological Alternatives.....	4-1
5	Pros and Cons of the Technological Alternatives.....	5-1
6	E9-1-1 Architecture Recommendations .....	6-1
6.1	Near-Term Architecture Recommendation.....	6-1
6.2	Long-Term Target Architecture Recommendation .....	6-2
7	E9-1-1 Network and System Architecture Design.....	7-1
8	Database Specifications, Migration Plan, and High-Level Business Case .....	8-3
8.1	Technical Specification.....	8-3
8.2	Database Migration Plan.....	8-3
8.3	High-Level Business Case.....	8-3
	Appendix A – Acronyms.....	A-1



# 1 Introduction

The Enhanced 9-1-1 (E9-1-1) network continues to evolve to keep pace with technological advances, such as Geographic Information Systems (GIS), Telematics, and Internet Protocol (IP); and regulatory mandates, such as Wireless Phase I and Phase II. In addition, interconnection arrangements have become quite complex as a result of an increase in wireless traffic, private networks, and the Internet. Therefore, it has become necessary for the State of California to develop an overall E9-1-1 network evolution strategy that will support these advances, satisfy the mandates, and meet customer demand. However, it is critical that the existing E9-1-1 Service is not adversely impacted by the use of new technologies, protocols, and interconnection architectures.

## 1.1 Project Overview

The State of California is drawing on the combined expertise of Telcordia and SAIC to help redefine and advance future emergency communication services. The project, Public Safety Next Generation E9-1-1 Network (NGEN), is a multi-year effort involving a wide range of stakeholders, from county and city governments to state and national level standards bodies.

This initiative offers a progressive solution to California's current 9-1-1 network limitations, by offering an E9-1-1 architecture that will incorporate the latest technologies, such as GIS, Telematics and automatic location information from Wireless Service Providers (WSPs). The network plan will also accommodate an evolution to packet data networks and Voice over IP (VoIP).

In this initial engagement, the SAIC/Telcordia team is working together to deliver E9-1-1 network analysis consulting services to the California Department of General Services Telecommunications Division (DGS-TD) 9-1-1 Office.

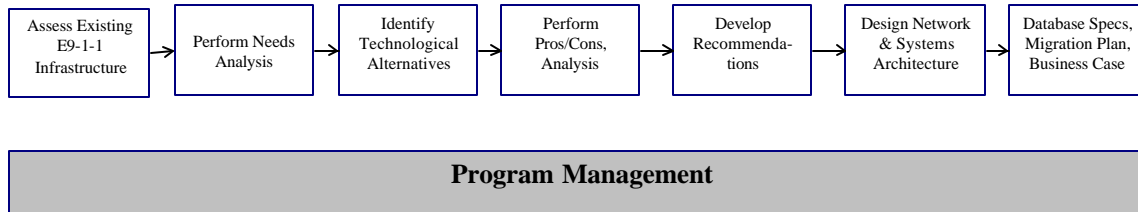
After completion of this work, California will have system and functional specifications for a new database architecture, as well as a migration plan and high-level business case to support the migration to the proposed database architecture.

From the team's assessment and input, a framework can be developed to establish a new network that addresses security and can accommodate relevant emerging technologies pertaining to voice, data, and GIS for Public Safety Answering Points (PSAPs). It will also be able to provide a comprehensive system platform for monitoring network, database, and equipment services for which the state's 9-1-1 Office must reimburse.

## 1.2 Project Management Plan

The Project Management Plan (PMP) describes SAIC and Telcordia's plans to deliver E9-1-1 network analysis consulting services to the California DGS-TD, 9-1-1 Office, as described in the Public Safety NGEN Statement of Work (SOW). The analysis approach followed by the SAIC/Telcordia team is depicted on the next page.

## SAIC/Telcordia's E9-1-1 Analysis Approach



### 1.3 Project Deliverables

The project Deliverables are described in detail in the SOW. A brief description of each Deliverable follows:

1)	<i>The Project Management Plan.</i>
2)	<i>Enhanced 9-1-1 Network Assessment</i> – analyzes the existing E9-1-1 network for the State of California.
3)	<i>Enhanced 9-1-1 Needs Analysis</i> – identifies current and future high-level capacity and service functionality needs of California's E9-1-1 network and systems, including PSAP equipment and databases.
4)	<i>Enhanced 9-1-1 Technological Alternatives</i> – describes existing and forward-looking network architecture and technology alternatives for satisfying California E9-1-1 service needs.
5)	<i>Pros/Cons Analysis</i> – discusses the pros and cons of each technological alternative defined in Deliverable #4.
6)	<i>PowerPoint Presentation</i> summarizing Deliverables #4 and #5 given in person at a meeting of DGS-TD representatives.
7)	<i>Enhanced 9-1-1 Architecture Recommendations</i> – makes recommendations for replacing and enhancing the existing California E9-1-1 network architecture.
8)	<i>Enhanced 9-1-1 Network and Systems Architecture Design</i> – provides a high-level network design, proposed changes to network elements and routing, and proposed PSAP equipment functionality.
9)	<i>PowerPoint Presentation</i> summarizing Deliverables #7 and #8 given in person at a meeting of DGS-TD representatives.
10)	<i>Database Technical Specifications, Migration Plan, and High-Level Business Case</i> – describes the system and functional requirements of the databases, and includes the steps necessary for a migration plan and a high-level business case to support the deployment of the databases.

11) *Status Reports* – provides tracking progress on project Deliverables, risks, issues, and contingencies. A Status Report is delivered to DGS-TD every two weeks.

## 1.4 Document Structure

The remainder of this document is organized as follows:

- **Section 2:** Network Assessment – Existing California Infrastructure
- **Section 3:** E9-1-1 Needs Analysis
- **Section 4:** Technological Alternatives
- **Section 5:** Pros/Cons Analysis
- **Section 6:** E9-1-1 Architecture Recommendations
- **Section 7:** E9-1-1 Network and System Architecture Design
- **Section 8:** Database Specifications, Migration Plan, and High-Level Business Case
- **Appendix A:** Acronyms



## 2 Network Assessment – Existing California Infrastructure

The first step in planning a Next Generation E9-1-1 Network (NGEN) is to assess the existing E9-1-1 network, and its supporting components, interconnections, and processes. By examining the current E9-1-1 infrastructure, it was then possible to establish what additional functionality would be required to meet the needs of the evolving E9-1-1 network and systems.

The *E9-1-1 Network Assessment* is a reflection of the existing wireline and wireless E9-1-1 network infrastructure in the State of California today. This assessment is a culmination of information received and analyzed by SAIC/Telcordia, using various methods of data gathering, including on-site interviews, State-furnished documentation, and stakeholder responses to questionnaires. As the subsequent Deliverables were produced, this assessment was used as a foundation to evolve to a NGEN for the State of California.

The assessment considers the State of California's current E9-1-1 network architectures for both wireline and wireless E9-1-1 support. All E9-1-1 supporting network elements, including PSAPs, Selective Routing Databases (SRDBs), Automatic Location Identification (ALI) databases, and E9-1-1 Tandems, are examined. Supporting E9-1-1 operational elements, such as Management Information Systems (MISs), as well as functions that support the 9-1-1 Office are also described.

This Deliverable includes a Functional Entity Model (FEM) to reflect E9-1-1 Service in the State of California. The FEM divides the overall functionality for E9-1-1 Service into functional entities. For example, the E9-1-1 Service functional entities include Emergency Call Detection (within wireline and wireless networks), E9-1-1 Call Processing (wireline and wireless), Selective Routing Determination, Alternate/Default Routing, PSAP Call Handling, Call Transfer, Performance Monitoring/Data Collection, etc. Examples of the 9-1-1 Office functional entities include Invoice Processing, Analysis of Funding Requests, Monitoring of Service Performance, etc.

The existing wireline E9-1-1 architecture in the State of California today includes SBC and Verizon Class 5 end offices, E9-1-1 Tandems/Selective Routers, ALI databases (implemented by SBC and Verizon in ALISA systems), and a Database Management System (DBMS). The Customer Premise Equipment (CPE) resident at the PSAP typically includes a 9-1-1 controller, telephone/work station, voice recorder, printer, and possibly a Computer Aided Dispatch (CAD) system. Packet data networks (i.e., X.25 and Frame Relay) are used to support the retrieval of location information for E9-1-1 calls, and IP networks are used to interconnect ALI databases belonging to different service providers (and to transport call detail information to the 9-1-1 Office). In addition, the E9-1-1 System in the State of California includes operations support systems that are responsible for surveillance of the different system components, collecting performance data, and generating alarms when appropriate.

The existing wireless E9-1-1 architecture in the State of California includes California Highway Patrol (CHP) Communication Centers that serve the majority of wireless 9-1-1 calls in California. Local PSAPs (e.g., San Francisco) may also answer wireless 9-1-1 calls directly from areas not under the jurisdiction of CHP, if there is agreement that the routing of wireless 9-1-1 calls in this manner is economically and technologically feasible and will benefit public safety.



### 3 E9-1-1 Needs Analysis

The *Enhanced 9-1-1 Needs Analysis* is a critical step for planning an overall network evolution strategy that utilizes the technological advances occurring today (e.g., GIS, IP). By analyzing the existing 9-1-1 network in the State of California, and determining the current and future service functionality needs, a basis can be established that assists in developing technological alternatives to be considered by the State of California DGS-TD 9-1-1 Office.

The *E9-1-1 Needs Analysis* was based on an analysis of the information obtained during the E9-1-1 Network Assessment, and also reflects needs identified during on-site interviews and in State-furnished documentation. This analysis identified near-term needs as identified by DGS-TD personnel and other stakeholders (e.g., PSAPs), and also addresses longer-term needs, such as GIS data requirements and the ability to receive Automatic Collision Notification (ACN) data.

The following types of needs were identified and documented:

- Needs related to the 9-1-1 Office that are not being met today, or are anticipated as future needs to ensure successful operation and management of emergency telephone systems
- Needs related to a 9-1-1 call (which may be a voice, data or a multimedia call) originating from a wireline or wireless access/network
- Needs that apply to CHP Communication Centers as well as to local PSAPs
- Needs related to E9-1-1 databases, such as the ALI and the SRDB

The *E9-1-1 Needs Analysis* was instrumental in determining the appropriate technological alternatives that were considered for a NGEN in the State of California.

As previously stated, the needs and their relative priority were expressed by the users and stakeholders of California's E9-1-1 system, and documented from the information obtained during on-site interviews, telephone conversations, and the review of State-furnished and other documentation. In cases where it was not possible to contact stakeholders directly during the data collection period, the team obtained information from groups representing those stakeholders; i.e., from National Emergency Number Association (NENA), American National Standards Institute (ANSI), California Emergency Services Advisory Board (CESAB), and other standards bodies and representative committees. The needs documented in this analysis reflect the information obtained from the following user classes:

- PSAP E9-1-1 call takers, office supervisors, and management
- E9-1-1 County Coordinators
- E9-1-1 Wireline Service Providers
- 9-1-1 Wireless Service Providers
- E9-1-1 CPE Suppliers
- CHP Communication Center supervisors, and representatives
- Language Translation Services Provider
- 9-1-1 Office Management

Users and stakeholders continued to provide valued input and feedback to the project team during the development of subsequent Deliverables.

Examples of several needs identified during the analysis were:

- Need for accurate data in the MSAG, ALI, and SRDB databases to facilitate routing of 9-1-1 calls to the appropriate PSAP and to support the dispatch of emergency service personnel.
- Need to ensure timely maintenance of the MSAG, ALI, and SRDB databases to minimize the number of misrouted calls.
- Need to accommodate static and dynamic location information in a more flexible, timely and cost-effective design.
- Need to restrict access to caller location information and associated data to those entities with a need to know.
- Need to integrate CHP Communications Centers and local PSAPs into a common E9-1-1 network structure to handle all 9-1-1 calls, providing relief for over-burdened CHP Communications Centers, and allowing them access to ALI data.
- Once a call has been identified as an Emergency Call, there is a need to provide the call with priority handling in comparison to “non-emergency” calls.
- Need for caller location information to be delivered along with the call to the PSAP.
- Need for fast, accurate delivery of callback number on all emergency calls (voice and data).
- Need to reduce emergency call setup time.
- Need to minimize PSAP isolations.
- Need to be able to transport 9-1-1 data between PSAPs related to a transferred call.
- Other types of emergency call originations, such as packet data calls and multimedia calls need to be supported by any forward-looking E9-1-1 architecture.
- CHP Communication Centers and local PSAPs need to be able to access GIS map data.
- Need for databases to support geodetic location information as well as traditional location information for wireless Phase II.

## 4 Technological Alternatives

The *Enhanced 9-1-1 Technological Alternatives* proposal was developed based upon the established *E9-1-1 Network Assessment* and *E9-1-1 Needs Analysis*, together with the technical knowledge related to advances in telecommunications today (e.g., VoIP and GIS). These alternatives include some elements of the existing E9-1-1 network in the State of California today (e.g., E9-1-1 Tandem), as well as more forward-looking (e.g., Call Management Server [CMS]) network elements being developed for Next Generation Networks (NGNs). These alternatives, together with the next Deliverable, *E9-1-1 Pros/Cons Analysis*, lay the groundwork for a recommended NGEN solution.

The *E9-1-1 Technological Alternatives* proposal identified multiple architecture alternatives for the E9-1-1 network, the PSAPs, the Databases (e.g., location, routing, and jurisdiction management), GIS, and the 9-1-1 Office. Various interconnection alternatives are discussed, as well as access interfaces (to Local Exchange Carriers [LECs] and PSAPs).

Examples of the types of architecture alternatives described are

- Network architectures, including:
  - An E9-1-1 Tandem-based infrastructure, with enhanced PSAP interface
  - A Public Switched Telephone Network (PSTN)-based infrastructure, without E9-1-1 Tandems
  - A packet-based architecture where NGN elements replace the E9-1-1 Tandem
- PSAP architectures, including:
  - An E9-1-1 PSAP Enterprise packet data network (Private or Virtual Private Network)
  - Custom Integrated Services Digital Network (ISDN)/Analog interfaces from the E9-1-1 Tandem
  - Use of National ISDN features on PSTN local switches to support emergency calls
  - VoIP architectures
- Database architectures, including:
  - Multiple localized master databases for location and routing functions
  - Single centralized database for location and routing functions
  - Multiple or centralized databases to support jurisdiction management
- GIS architectures, including:
  - GIS applications for the Location /Routing Database (LRDB)
  - GIS applications for the PSAP
  - GIS applications for the Jurisdiction Management Database (JMDB)
  - GIS applications for the 9-1-1 Office
- 9-1-1 Office architectures, including:
  - New 9-1-1 Office system integrating MIS and Invoicing Information

- New 9-1-1 Office system with GIS presentation layer
- New 9-1-1 Office system with Project Collaboration Environment

In addition, the Deliverable addressed the compatibility of the various network component architecture alternatives, and considered any constraints on the interworking of the alternative architectures with each other.

## 5 Pros and Cons of the Technological Alternatives

The *Enhanced 9-1-1 Pros and Cons* are based on the technological alternatives evaluated as part of the previous Deliverable, *E9-1-1 Technological Alternatives*. Interactions were held with several stakeholders, including SBC, Verizon, and CESAB in an attempt to identify their views of the pros and cons of each proposed network, PSAP, and database alternative. Switch, PSAP equipment and database suppliers were also queried in an attempt to obtain relative cost information for the alternatives. The pros and cons identified in this Deliverable, together with the previous *E9-1-1 Technological Alternatives*, provided the basis of a recommended NGEN solution for the State of California.

A number of pros and cons associated with each of the previously identified technological alternatives for the E9-1-1 network, the PSAPs, the Databases (e.g., location, routing, and jurisdiction management), GIS, and the 9-1-1 Office were identified. Relative comparisons of the technological alternatives were made in terms of:

- Consistency with the State of California's short-term and long-term goals
- Scalability
- Increased/enhanced functionality
- Possible operational impacts
- Equipment availability, compatibility, and relative costs.

**Examples of several Pros and Cons related to the Network Architecture Alternatives are as follows:**

### ***E9-1-1 Tandem-based Architecture, with enhanced PSAP interface:***

**Pros:** Integrates CHP Communication Centers into a single network structure with other PSAPs; gives CHP access to same ALI/ANI information available to other PSAPs; does not require modifications to switching systems for detection of Emergency Calls

**Cons:** Enhancements to E9-1-1 Tandem-to-PSAP interface to support National ISDN are neither available nor planned for implementation in already deployed E9-1-1 Tandems. CHP will have to migrate to an E9-1-1 Tandem-based interconnection arrangement.

### ***A Public Switched Telephone Network (PSTN)-based infrastructure, without E9-1-1 Tandems***

**Pros:** May be able to leverage existing functionality at end offices/MSCs to support Selective Routing query; existing SS7 connectivity between end offices can be used for alternate-routed and transferred calls.

**Cons:** Enhancements would be required to originating and terminating end office functionality and interfaces; development of new feature functionality on existing circuit-based switching systems may

not be supported by equipment supplier or network provider due to cost/strategic business considerations.

***A packet-based architecture where NGN elements replace the E9-1-1 Tandem***

**Pros:** Elements of NGN can be designed to support the desired functionality (e.g., selective routing, alternate routing, transfer) and interfaces to support the handling of Emergency Calls; Savings to State since dedicated trunk groups no longer need to be supported.

**Cons:** Although consistent with evolutionary plans of equipment suppliers and network providers, wholesale replacement of E9-1-1 Tandems with NGN elements is not likely to be generally available in the near term. The packet network security, reliability and Quality of Service (QoS) issues will need to be addressed if a packet network is to be used for E9-1-1 services.

**Examples of Pros and Cons related to the PSAP Architecture Alternatives are as follows:**

***An “E9-1-1 PSAP-Enterprise” packet data network (Private or Virtual Private Network)***

E9-1-1 PSAP-Enterprise packet data network connectivity is common to all the PSAP architecture proposals, so its pros and cons are summarized here for all alternatives.

**Pros:** Packet data network infrastructure can support additional flexibility and functionality for NGEN database access and for data transfers between PSAPs. An IP packet-based network can be designed to provide more reliable, robust access to network, shared databases, and to other PSAPs. Many PSAP CPE are already IP-capable for data.

**Cons:** Some additional expense initially (at PSAP and other network/database elements) to migrate existing functionality to an IP-based network, and to ensure secure access, may not prove in economically until increased bandwidth requirements are seen (e.g., for increased data transfer, voice services, etc.).

***Custom ISDN/Analog interfaces from the E9-1-1 Tandem***

**Pros:** ISDN provides more reliable access signaling than MF trunks due to layer 2 continuity/error checking. ISDN can provide reduced call setup time and enhanced information. With ISDN, voice and data calls can be established simultaneously to support transfers and multimedia calls between PSAPs. (This benefit will be reduced if ISDN capabilities are not supported by PSAPs at both ends of the transfer.)

**Cons:** ISDN would require modifications/enhancements to CPE in almost all PSAP CPE deployed in the State of California, resulting in increased cost of CPE. The cost increase is estimated to be equivalent to implementing VoIP. Vendor choices are very limited, and equipment compatibility issues exist. ISDN features, even with E9-1-1 enhancements, may not support all existing capabilities, or support them in the same way, impacting PSAP operations and training. Distance limitations may prevent some PSAPs from being served by ISDN BRI from more distant E9-1-1 tandems. ILECs have not indicated an interest in developing ISDN interfaces to their E9-1-1 Tandems.

***Use of National ISDN/Analog Centrex features on PSTN local switches to support emergency call delivery to all PSAPs (CHP Model)***

**Pros:** The advantages of this alternative are the same as in the previous one. In addition, with this alternative ISDN distance limitations are not as much of a concern as in previous alternative. Also, this alternative does not require re-trunking of CHP Communications Centers to connect to E9-1-1 Tandems.

**Cons:** The use of National ISDN has the same disadvantages as in the previous alternative. These disadvantages also apply to analog Centrex service. This alternative will result in changes in access facilities for most PSAPs, and an increased possibility of isolation.

***VoIP Architectures***

**Pros:** This alternative has the potential for decreased call setup time, as well as increased flexibility, functionality and control. It also has the potential for customizing transfer and redirection capabilities, and for including new functionality in PSAP CPE and network elements more quickly. Savings on access costs may be achieved if common access can be used to support many voice and data services. With this alternative, the probability of isolation may be decreased, and the ability to relocate PSAPs quickly in emergency situations is improved. The IP packet data network infrastructure can support additional functionality for database access, and data transfers between PSAPs. Many PSAP CPE are already IP-capable for data.

**Cons:** IP is a mature technology for data, but VoIP is not yet a proven technology for emergency services. VoIP equipment availability and compatibility may be issues initially. Quality, reliability and security are still open issues with respect to VoP technology and design. CPE upgrades will be required. Availability of broadband access to all PSAPs may be a challenge initially.

**Examples of Pros and Cons related to the Database Architecture Alternatives are as follows:*****Multiple Local Location/Routing Databases (LRDBs) based on “ownership” of the location data.***

**Pros:** This alternative has the potential for allowing each data owner to store and maintain their location and routing data rather than depending on other entities to do this. It removes the delay in updating a third-party database with locally generated information. Distributed LRDB architecture means that lack of availability of a given LRDB will not impact location-based capabilities for all emergency callers.

**Cons:** It may be undesirable for all data “owners” to maintain their own database. For PSAPs, it becomes more complex to determine which database should be accessed when there may be more than one to choose. As a result, there may be more steered queries resulting in increased data retrieval times. A more complex NGEN Database data network may be needed and more

authentication/authorization requirements arise. There is more complexity for the 9-1-1 Office to provide oversight of each LRDB and to support billing operations for more LRDB providers. There do not appear to be any significant opportunities for cost savings to the 9-1-1 Office associated with this database alternative. This alternative is the least cost efficient because costs of maintaining the LRDB, secure site access, facilities for steering, and new GIS capabilities, are multiplied.

### ***Single Centralized Mated Pair of LRDBs***

**Pros:** This alternative has the least potential for location query delays. It minimizes 9-1-1 Office oversight and processes since only one LRDB provider is needed. It is the most scalable alternative, since steering of queries is not required and requires the fewest interfaces of all alternatives considered. Additionally, it provides the least complex requirements for synchronization with GIS data since there is no need to determine how to segregate GIS data and provide each LRDB with only the GIS data that it needs. It enables efficient support for routing queries, since each service provider queries the same LRDB rather than having to determine which, of multiple LRDBs, should be queried for a given call. Based on rough cost data from other states, there is a potential savings in annual costs compared to the current ALI DB/ SRDB system, if consideration is given to State restructuring of the current E9-1-1 database architecture.

**Cons:** The cost of moving existing data to a centralized LRDB needs to be accounted for. It will require coordination with data owners and data suppliers who may be reluctant to participate. In addition, there will be operations/training impact on existing update processes to comply with new authentication/authorization security requirements.

### ***Single Centralized Mated Pair of Jurisdiction Management Databases (JMDBs)***

**Pros:** A single, centralized JM Database can also support local control of data by specification of access control and privileges for each JM-controller. When GIS capabilities are supported, it is easier to identify/reconcile inconsistencies in boundary definitions in a single centralized JM-Database. E9-1-1 oversight is simplified. It may be possible to integrate statewide JM Database functionality with statewide GIS database functionality. It is easier to support localities that do not yet provide a local JM/GIS database. It provides a single point of access for providers of location records to access JM data to perform pre-validation of location record information before submission to the LRDB.

**Cons:** The cost of moving existing data to centralized JMDB needs to be accounted for. Separation of this functionality from the LRDB may have an impact on the LRDB. Coordination with LRDB provider(s) will be needed.

## 6 E9-1-1 Architecture Recommendations

The *Enhanced 9-1-1 Architecture Recommendations* were proposed in terms of both a near-term target architecture (“5-year view”) that assumes the technologies and implementations for the recommended architectures will be available in a timeframe of approximately five to ten years, as well as a target NGEN architecture recommendation (“10+ year view”) that assumes the technologies and implementations will most likely not be available for at least ten years. There is no definitive way to know exactly when the evolving technologies will be feasible for deployment. However, SAIC/Telcordia has taken the view that a VoIP-based infrastructure will eventually be universal within the carrier networks, but not within the “5-year plan” as proposed in this Deliverable. In addition, SAIC/Telcordia has also taken the view that there may be a need to support multiple E9-1-1 architectures during the next five years, depending on the functionality of the existing end offices (e.g., querying capability) and the needs of the various PSAPs. These architectures are considered within the migration strategies proposed.

The *E9-1-1 Architecture Recommendations* were based on the analysis of the architectural alternatives, together with the pros and cons identified for each. For each architectural alternative, the pros and cons were analyzed as they met the following criteria:

- Long-term and short-term goals
- Scalability
- Increased or enhanced functionality
- Operational impacts
- Facility Impacts
- Compatibility
- Product/Equipment Availability
- Cost

In addition, the needs identified during the *E9-1-1 Needs Analysis* were compared with each of the architectural alternatives, and analyzed in terms of the number of needs met (or not met) as well as how well the needs were met by a particular proposed architecture. The recommendations and migration strategies address overall system architectures, cost estimates, network elements, interfaces, and justifications.

### 6.1 Near-Term Architecture Recommendation

The near-term architecture introduces an IP-based backbone network to provide high-speed reliable access to location, routing, and GIS functionality, and to improve communications between elements of the E9-1-1 system. E9-1-1 Tandems continue to play a central role in the near-term E9-1-1 system architecture. The continued use of E9-1-1 Tandems was recommended for the near-term architecture because it supports the evolution of the network toward a long-term target architecture where Selective Routing functionality is centralized, and where Selective Routing and PSAP access are supported by the same NGEN Managed IP Network. The near-term architecture supports Telematics and Medical Call Center (MCC) calls. In addition, Intelligent Network (IN)-based

implementations of E9-1-1 Service are accommodated, although the use of IN-based Selective Routing at End Office/Service Switching Points (SSPs) is not required.

The near-term voice network architecture was recommended due to its ability to meet many of the goals of the State of California. This architecture meets the goal of an integrated architecture where CHP Communication Centers share a common network structure with other PSAPs, and support for Telematics and MCC calls is integrated into the same network structure as wireline and wireless 9-1-1 calls.

Initially, some PSAPs will use the Managed IP Network primarily for data applications, but will continue to use conventional voice connectivity to the serving E9-1-1 Tandems and local offices in the PSTN. In the near term, to take advantage of converged access while retaining conventional CPE, some PSAPs may use a VoIP gateway function to provide the conversion from VoIP signaling on the Managed IP Network to analog/digital signaling supported by their existing CPE. Other PSAPs, with a need for additional new flexibility and functionality, may deploy VoIP-enabled CPE. Some PSAPs may choose to make a gradual transition, retaining existing conventional trunks and CPE, and using VoIP connectivity and CPE to provide only additional capacity at first.

The recommended database architectures include LRDBs, which provide the equivalent of today's ALI and SRDB functionality; as well as both Statewide and Local JMDBs, which are similar to the MSAG functionality provided today. The LRDBs are being introduced to combine the existing ALI and SRDBs into a centralized mirrored database pair to help improve the database operations cost, to improve the query response times by reducing inter-database routing of queries, and to make the LRDB more accessible (e.g., for data owners to be able to verify data online) to more LRDB users (e.g., by PSAPs for routing queries) than is available today. The Statewide and Local JMDBs are being introduced to help increase the accuracy of location data by incorporating GIS functionality, providing more control to county coordinators or their successor in updating and approving such data as well as making available the latest jurisdiction information to all county coordinators and PSAPs.

## **6.2 Long-Term Target Architecture Recommendation**

In the long-term architecture, the E9-1-1 Tandems are no longer present, and the functionality previously provided by the E9-1-1 Tandems (e.g., Emergency Call detection, Selective Routing) is assumed by elements of the IP-based backbone network. The IP-based high-speed data network is leveraged to support all voice and data communications for E9-1-1 Service in the State of California. In addition, standard interfaces are used to access the location and routing databases.

A NGEN Managed IP Network infrastructure was selected for the long-term target architecture due to the increased functionality it could support, and potential operational savings associated with providing a common network that supports emergency and non-emergency voice traffic, as well as data traffic. A key characteristic of the long-term architecture is the replacement of the E9-1-1 Tandems with elements of the NGEN Managed IP Network. These elements can be designed to efficiently support functionality formerly provided by specialized E9-1-1 Tandems, that is needed in the processing of emergency calls.

The evolution of the E9-1-1 system toward VoIP is consistent with the evolutionary plans of equipment suppliers and network providers, and reflects the directions described in National NENA's Future Path Plan.

## 7 E9-1-1 Network and System Architecture Design

The *Enhanced 9-1-1 Network and System Architecture Design* was intended to assist the State of California in discussing the future of E9-1-1 Service with E9-1-1 network and database providers, PSAP agencies, and wireless and wireline carriers. It proposed a high-level network design, and changes to network elements and routing, and PSAP equipment functionality. This Deliverable was based on the previous Deliverable, *E9-1-1 Architecture Recommendations*.

The *E9-1-1 Network and Systems Architecture Design* provides a description of the following:

- Proposed new or changed network elements
- Modifications to approaches for providing redundancy and route diversity
- Proposed changes to network trunking arrangements
- Proposed changes to signaling and transmission technology for various interconnection interfaces
- Proposed methods to support the sharing of GIS data
- Proposed PSAP equipment supplement/replacement needs
- Identification of required functionality and proposed changes/improvements to CAD system functionality/interfaces
- Proposed changes to required functionality, signaling, transport, and routing for interconnection with the E9-1-1 network
- Updated FEMs reflecting the proposed E9-1-1 network and system architecture.

The network architecture incorporates concepts and standards that permit a broad range of vendors to potentially participate in a multi-vendor, interoperable network and operational solution.

The key “themes” of the recommended architectures described in this E9-1-1 Network and Systems Architecture Design are:

- To reduce LRDB costs through competitive bidding
- To support migration toward the use of GIS capabilities to mechanize E9-1-1 data update, reconciliation and synchronization processes
- To provide an IP networking infrastructure for supporting E9-1-1 network functions
- To leverage the NGEN IP network for voice as well as data services (i.e., VoIP-based target architecture)

- To improve the network access interface to the PSAP using broadband and VoIP signaling
- To enable flexibility in relocating PSAP Emergency Call-handling capacity to enhance disaster recovery scenarios
- To migrate towards E9-1-1 specific application software on standard platforms and interfaces.

## 8 Database Specifications, Migration Plan, and High-Level Business Case

### 8.1 Technical Specification

The *Technical Specification* addresses outsourced LRDB and JMDB solutions that meet the needs described in *E9-1-1 Architecture Recommendations* and *E9-1-1 Network and System Architecture Design*. Since the database systems are expected to be managed and maintained by the database solution provider, this specification focuses on required functionality, application interfaces, and performance characteristics of the LRDB and JMDB, and not on the underlying database platforms.

The goal of the proposed LRDB and JMDB solutions is to support the accurate routing of Emergency Calls to the appropriate PSAP, to deliver location information to the PSAP to aid them in identifying the location of the caller, and to automate processes for data upload, validation, maintenance, and discrepancy resolution.

### 8.2 Database Migration Plan

The *Database Migration Plan* describes a proposed plan to migrate from the current E9-1-1 database architecture and processes to an architecture that consolidates location and routing functionality for the State of California in a mirrored LRDB pair. This plan allows for a standalone approach to the support of JM data (including current and future geo-spatially enabled versions of the MSAG data for the State of California), although support of the JMDB functions by the LRDB provider will also allow for successful migration to the new architecture. The migration plan includes eventual incorporation of GIS capabilities into the management of E9-1-1 JM data to support more responsive, automated processes for management of E9-1-1 data and for data discrepancy resolution among carriers and local JM controllers (i.e., County Coordinators).

This Deliverable provides a high-level overview of the migration strategy, an aggressive schedule for implementation, descriptions of proposed tasks to implement the migration, and an accompanying work breakdown structure of sub-tasks for the plan.

### 8.3 High-Level Business Case

Based on the *Technical Specifications* and *Migration Plan for Databases* presented previously, a *High-Level Business Case* for database migration was developed that included an estimate of costs incurred at each major stage of the database migration path, as well as a comparison of potential costs and benefits with those of the Present Method of Operation (PMO) and with a delayed version of the database migration plan. Specifically, the three scenarios examined in the business case analysis were:

- Present Method of Operation (PMO) – using two mirrored ALI Database pairs provided by each of SBC and Verizon, MSAG databases maintained by the ALI Database providers, and an SRDB that is integrated into the same ALISA platform that provides the ALI Database.

- Migration to the Target Database Architecture – Migration to the target database architecture was assumed to occur in three phases:
  - Phase 1 - deployment of a centralized LRDB pair and migration of existing location/routing data; deployment of a Statewide JMDB supporting tabular MSAG-based Location Validation data
  - Phase 2 - extension of the Statewide JMDB capabilities to include GIS-based JM data
  - Phase 3 - deployment of Local JM/GIS DBs supporting JM layers in the locally developed GIS data, with standard interfaces to the Statewide JMDB for automated GIS synchronization
- Delayed Migration to the Target Database Architecture – Similar to the previous scenario, with the assumption that migration to the target database architecture would be delayed by two years.

The output of the high-level business case analysis includes an estimate of the year-by-year staffing costs and investment requirements by scenario, a cost and benefit comparison of the three scenarios considered, and an analysis of the sensitivity of these results to a possible range of values of some of the key parameters and assumptions used in the business case analysis.

## Appendix A – Acronyms

<b>ACN</b>	Automatic Collision Notification
<b>ALI</b>	Automatic Location Identification
<b>ANI</b>	Automatic Number Identification
<b>ANSI</b>	American National Standards Institute
<b>BRI</b>	Basic Rate Interface
<b>CAD</b>	Computer Aided Dispatch
<b>CAMA</b>	Centralized Automatic Message Accounting
<b>CESAB</b>	California Emergency Services Advisory Board
<b>CHP</b>	California Highway Patrol
<b>CLEC</b>	Competitive Local Exchange Carrier
<b>CMS</b>	Call Management Server
<b>CPE</b>	Customer Premises Equipment
<b>DBMS</b>	Database Management System
<b>DGS-TD</b>	Department of General Services Telecommunications Division
<b>E9-1-1</b>	Enhanced 9-1-1
<b>EO</b>	End Office
<b>FEM</b>	Functional Entity Model
<b>ESZ</b>	Emergency Service Zone
<b>GIS</b>	Geographic Information Systems
<b>ILEC</b>	Incumbent Local Exchange Carrier
<b>IN</b>	Intelligent Network
<b>IP</b>	Internet Protocol

<b>ISDN</b>	Integrated Services Digital Network
<b>ISUP</b>	Integrated Services Digital Network User Part
<b>ITU</b>	International Telecommunications Union
<b>JMDB</b>	Jurisdiction Management Database
<b>LEC</b>	Local Exchange Carrier
<b>LRDB</b>	Location/Routing Database
<b>MCC</b>	Medical Call Center
<b>MIS</b>	Management Information System
<b>MPC</b>	Mobile Position Center
<b>MSAG</b>	Master Street Address Guide
<b>MSC</b>	Mobile Switching Center
<b>NENA</b>	National Emergency Number Association
<b>NGEN</b>	Next Generation E9-1-1 Network
<b>NGN</b>	Next Generation Network
<b>NMS</b>	Network Management Systems
<b>PBX</b>	Private Branch Exchange
<b>PMO</b>	Present Method of Operation
<b>PMP</b>	Project Management Plan
<b>PRI</b>	Primary Rate Interface
<b>PSAP</b>	Public Safety Answering Point
<b>PSTN</b>	Public Switched Telephone Network
<b>QoS</b>	Quality of Service
<b>SAIC</b>	Science Applications International Corp.
<b>SR</b>	Selective Router
<b>SRDB</b>	Selective Routing Database

<b>SS7</b>	Signaling System No. 7
<b>SSP</b>	Service Switching Point
<b>TCC</b>	Telematics Call Center
<b>TSP</b>	Telematics Service Provider
<b>VoIP</b>	Voice Over Internet Protocol
<b>VOP</b>	Voice Over Packet
<b>VPN</b>	Virtual Private Network
<b>WSP</b>	Wireless Service Provider
<b>XML</b>	eXtensible Markup Language